The Higher Education Academy Physical Sciences Centre

...enhancing the student experience in chemistry, physics and astronomy within the university sector

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# Wavelength

**In this issue:**



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## The impact of fees on student attitudes

A report looking into the impact of fees on student life, carried out by researchers at the University of Southampton and The Knowledge Partnership and funded by the **Higher Education Academy**, was published recently. The report shows that the impact of 'top-up fees' could change the whole campus experience for English students.

The one-year study on changing fee régimes and their impact on student attitudes to higher education was funded by the **Higher Education Academy** as part of its remit to lead the development of research to improve the quality of the student learning experience.

The study was undertaken by a team led by Professor Nick Foskett (University of Southampton), with David Roberts (The Knowledge Partnership), Dr Felix Maringe (University of Southampton) and Matt Hyde (Goldsmith's College).

It examined how universities in England are responding to the new fee model in their admissions policies and practices. It asked prospective students in England what they knew about the new fee régime, how this affected their decisions on whether and where to apply to university and their expectations about the nature and value of higher education.

Part of the study was based on interviews with Australian and New Zealand students, where fees can be as much as Aus$8,000. It reveals that the economics of student life have turned students there away from heavy partying and driven them to take study more seriously, supported by part-time jobs. Student life is also likely to be less campus-oriented and more drawn out, as students struggle to pay off their debts before they have even started a career.

The researchers concluded that:

- Potential students had a broad knowledge of the new fees system, and most knew that they do not have to pay fees upfront and can get loans. However, most had little knowledge of the detailed issues related to funding their study, such as the institutional support available to them in the form of grants, bursaries and scholarships
- Students are likely to be rational about the proposed fees increase in 2006, expecting that they will translate into better services and support for them during their years of study
- They are unlikely to base their decision to go to university primarily on the issue of fees; some are strongly inclined towards accessing careers first and using HE as a career enhancement strategy rather than as career finding strategy
- There does not seem to be any substantial evidence from Australia and New Zealand that suggests that increasing fees reduces participation in HE
- There is a likelihood of greater local participation in HE as a strategy to cushion students from increased costs of study. Alongside this will be a strong likelihood of parental involvement in the decision-making of their children about going to university.

**The full report is available at www.heacademy.ac.uk/4407.htm**

*Adapted from Higher Education Academy News (www.heacademy.ac.uk/).* ■

# The journey of an Idea

**The journey of an Idea: Entrepreneurship in the Physical Sciences**

Kevin Byron received his doctorate in applied physics from the University of Hull and after graduation spent some twenty five years in research in the telecommunications industry. During this period he published over fifty patents and a similar number of technical publications. He was also an honorary visiting lecturer at the University of Glasgow and Visiting research fellow at the University of Salford.

In 2001 he was awarded a Research Fellowship with The National Endowment for Science, Technology and the Arts (NESTA) in the UK for studies of creativity in science education. After completing the fellowship he established Etc (Education & training in creativity) - a private consultancy delivering lectures and workshops on many aspects of creativity and critical thinking to a variety of educational institutions and businesses. His clients have included the East of England Development Agency, The UK Centre for Integrated Photonics, Dixons, The CASS Business School and The Royal Institution. He is currently working with UK universities developing teaching resources on creativity and entrepreneurship. Kevin is a Fellow of the Institute of Physics and a visiting fellow of the Higher Education Academy Physical Sciences Centre, based at the University of Hull.

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**Introduction**

This is the first of two articles on 'Entrepreneurship in the Physical Sciences' and is an introduction to an enterprise resource being developed by the Higher Education Academy Physical Sciences Centre, for teaching staff.

The resource will include all the materials for the delivery of a module of lecture/ workshops on entrepreneurship targeted at (final year) undergraduates. As described later, entrepreneurship in its modern usage is more akin to an *attitude to change* than it is about setting up a business. However this more generic definition is best exercised and understood through seeing it in the framework of creating a new business. So whilst many students may have no ambitions to set up a new business there is a great deal they can learn for any future career in the tools and techniques of entrepreneurship and adopting the skills of the entrepreneur.

For simplicity in the resources the development of an enterprise has been likened to the journey of an idea from initial inception through to the launch of a business that markets the idea. To meet the various challenges at each stage different resources, tools and techniques are provided as handouts and exercises to enable that stage to be completed. The resources include forms (eg Patent applications, Business plans, Cash flows) that would need to be filled in, creative thinking tools that need to be used and information about skills that need to be practised. General information will also be supplied to enable the prospective entrepreneur to carry out further research on their particular idea and how it might be exploited. One of the most important skills, if that is a suitable description of it, that is common to all of the stages is creative thinking. The aim of this article is to define some of the terms that will be used in the resource and to show what they have in common and where they differ.

**Entrepreneurship**

The word entrepreneur can be traced back to the 13th century in the French verb entreprendre, meaning 'to do something' or 'to undertake'. Three hundred years later the noun 'entrepreneur' appeared referring to someone who undertakes a business venture and to quote an expert of that era Jean Baptiste Say: someone who "shifts economic resources out of an area of lower and into an area of higher productivity." In 1848 the English philosopher and political economist John Stuart Mill differentiated the entrepreneur from someone who organises a business in a conventional way using existing ideas. He identified in the entrepreneur someone who assumes the risk and is responsible for the management of a new business.

So the entrepreneur is someone who sees opportunities that may be gaps or discontinuities in markets or organisations and is motivated to bridge these gaps or eliminate the discontinuities with new ideas. This may mean the creation of a new product or service but it does not necessarily mean setting up a new business. For example in recent years civic entrepreneurship has been established with the aims of practising sustainable development through action. Civic entrepreneurs are driven by public interest and seek to create new ways of building social capital. They achieve this through harnessing new ideas (eg inventions, technologies, resources or management systems) in the service of collective goals.

A modern definition of the entrepreneur emerging from the study of business as an academic discipline over the last fifty years concerns attitude and behaviour. In his book 'Innovation & Entrepreneurship' Peter Drucker describes it in this way:

"Entrepreneurship is neither an art nor a science but a practice."
"The entrepreneur always searches for change, responds to it, and exploits it as an opportunity."

So the skills of entrepreneurship are relevant to all undergraduates irrespective of whether they aspire to start a new business or to be employed by an organisation. Indeed the underlying skills of entrepreneurship are essential for anyone with an ambition to be successful in their chosen career. To this end it is useful to look at any organisation as consisting not just of a number of employees but as an equal number of small businesses. The individual runs their own business within the business and aims to be successful both through cooperation with others and through individual initiative to enable the overall business to thrive and expand. If there is any trick to forging a successful career then it is adopting an entrepreneurial attitude in one's own profession.

Household names like Richard Branson, Alan Sugar, Martha Lane-Fox and Anita Roddick are often cited as good examples of people living the spirit of entrepreneurship. Their ability to build business empires from almost nothing may give the impression that entrepreneurship is a rare talent possessed by a gifted minority. But they are the 'Rock Idols' of entrepreneurship and in the same way one might find

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great talent in a local music band one need go no further than the high street to find similar examples of entrepreneurship. Indeed observing and identifying how other people have developed a business or presented a new idea is a good starting point for anyone wishing to express their entrepreneurship through a new business start-up.

In the same way that scientists express their creativity in the lab and artists express theirs in the studio or atelier, successful entrepreneurs express their creativity in business. The commonly held belief that entrepreneurs are driven purely to make money does not hold - to many successful entrepreneurs that is a secondary consideration as indeed it is for artists and scientists. Creativity comes first - the desire to solve problems irrespective of their nature is a defining characteristic of humanity.

Problems come in all shapes and sizes and one of the characteristics of entrepreneurs is that they are always on the look-out for problems. These problems may just arise in daily life but instead of living with a problem like many of us do, the entrepreneur is motivated to go further. He or she takes very little for granted, constantly asks question and believes they can make a difference. The sort of questions that an entrepreneur might ask when interested in an everyday problem that they see as a challenge to solve are:

How could this be improved? What changes could be introduced? Why is this happening?
What is not happening? What is taking too long? Where is there wasted effort and resources?
Where are the bottlenecks? What is not working efficiently? What is causing problems?
Who is involved? When does this happen? etc

These questions are sometimes referred to as the 5Ws + 1H (Who?, What?, Where?, When?, Why and How?) and are constantly asked and answered at each stage of the development of an enterprise in order to develop and shape it for the next stage. The 5Ws +1H is one of many tools used to facilitate creative thinking. It can be applied to diversify the range of challenges one would like to work with or as a means of abstraction to get to the heart of a problem.

To take a simple example of the latter if the challenge we set ourselves was ‘How do I make a better mousetrap?’ The usual way to go about this is to study existing mousetraps and incorporate the best design features and eliminate the worst design features and we finish up with our own unique design. This may be a great mousetrap but it is not a creative solution. This conventional approach is a low risk, incremental solution and is often how established businesses progress when they have a successful product. If instead we ask a different question using the 5Ws + 1H tool such as ‘Why do I want to build a better mousetrap?’ we may come up with the answer: "Because I want to get rid of the mice!" By then re-casting the original problem as ‘How do I get rid of the mice?’ it still meets the original challenge but we are no longer thinking about conventional mousetraps and may come up with creative alternatives.

This is just one simple example of how entrepreneurs engage with problems and draw on a creative attitude to re-frame problems and to shift their perspective in order to find new ideas for businesses.

**Creativity**

There are many other tools that can be used to find ideas and these will be described in some detail in the resource. At this stage however it is useful to define more clearly what is meant by creativity. Creativity can be expressed through virtually any form of human behaviour and everyone has a range of creative abilities. Two of the characteristics that separate highly creative people from the less creative are risk-taking and tenacity. In this context ‘risk-taking’ describes the impulse to find and try original ideas, to go beyond ones’ familiar boundaries of knowledge and explore new possibilities rather than staying in the relative security of what we already know. The risk is that the ideas will be deemed impractical, inappropriate or crazy but undaunted by failure the entrepreneur will play around with many ideas until one good one turns up or maybe more accurately one turns up for which the time is right. Many people have great ideas for businesses but bringing an idea to life is never straightforward. The creativity that produced the idea in the first place needs to be channeled into problem-solving at each stage of the development of an enterprise. Nevertheless the skills to meet the various challenges that appear can all be taught and the problems approached in a systematic way.

One approach that has found widespread application in the USA and Canada is known as the Osborn-Parnes process. This was first developed by Alex Osborn who coined the phrase ‘Brain-Storming’ in the

*“Entrepreneurship is neither an art nor a science but a practice.”*
*“The entrepreneur always searches for change, responds to it, and exploits it as an opportunity.”*

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1950s. Later working with Sid Parnes and others associated with CPSI, The Creative Problem Solving Institute, the process was fully developed.

It consists of six stages shown in Fig 1 and at each stage two modes of thought are applied. Divergence comes first in which as many thoughts as possible are written down in connection with the particular stage of the process. Divergent thinking looks outside the boundaries that define the problem. In this mode of thought it is essential to defer judgement on the value of anyone's thoughts until enough of them have been generated. This is a learnt skill and the more debate that ensues the fewer ideas are generated during this time. Convergence comes next where we select from the list those ideas that are the best and here judgement is essential. The criteria for selection of ideas are based on asking the following three questions: How important is this idea or problem?, How much Influence do you have in making it happen? How much does it represent or need a New Idea? This process provides a framework for creative thinking which is essential if an idea is going to be taken seriously and developed into a force for change.

**Innovation**

The words creativity and innovation are often used in the same sentence and they are also often randomly inter-changed as if they had the same meaning. There is some overlap in their definitions in that innovation can describe the process of coming up with new ideas but more often innovation refers to what happens after someone has been inspired by a creative idea. A working definition of innovation is given below:

***A connected process in which many activities from research through to support are coupled together in an integrated way for a common goal.***

Innovation is more concerned with making creative ideas a reality. Innovation management describes the procedures and practices that are set up in a business in order to enable a smooth transition from creative idea to a marketed product or service. Innovation begins with communication of the idea and ends with a team with various roles working together to bring the idea as efficiently and as quickly as possible to fruition.

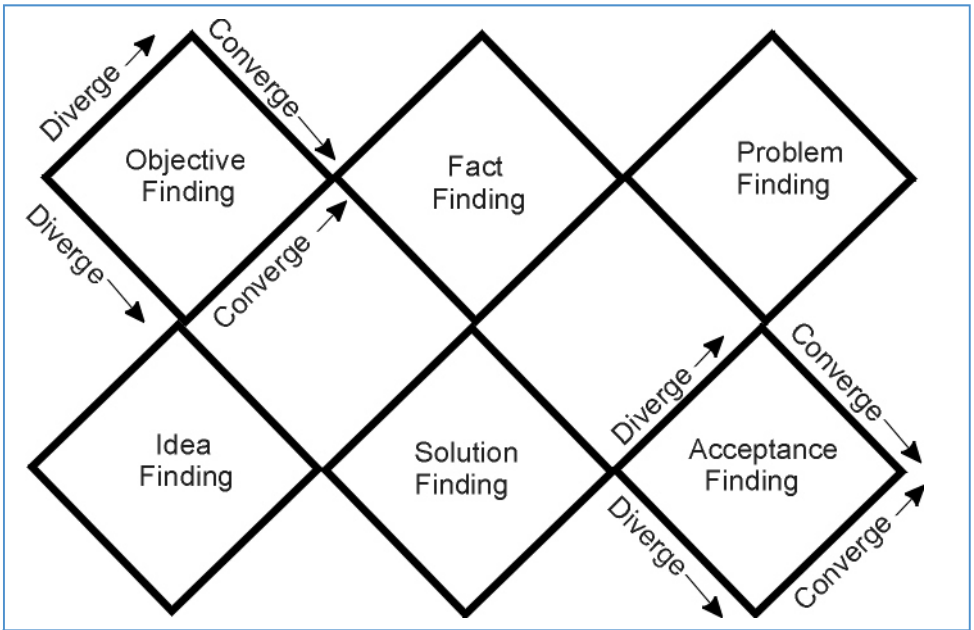


Fig 1: Schematic of the Osborn-Parnes Process

In summary an entrepreneur is firmly placed in the business of innovation. An innovation manager in a business however may or may not be an entrepreneur. An entrepreneur will be working with creative ideas, seeing their potential and developing them into a reality.

Throughout the process of developing an enterprise ideas undergo a number of transformations that require different skills from the entrepreneur and the team. In the next article the various stages in the development of an enterprise will be described in detail along with the different skills required to complete each stage. ■

*Throughout the process of developing an enterprise ideas undergo a number of transformations that require different skills from the entrepreneur*

# Strategically important subjects

**Introduction**
HEFCE is supporting and developing a number of projects to address issues of student demand for STEM subjects deemed to be both strategically important and vulnerable. The term STEM, and in particular the 'science' element of it, covers a wide variety of disciplines. So far they are concentrating on chemistry, physics, computing, engineering and maths.

The approach is to address the core issues as they have been determined by subject communities made up of learners, educational providers, employers and regional bodies.

Projects will look to both increase and widen participation in STEM subjects. To support HEFCE's strategic aim to widen participation in higher education, they are required to have key connections with Aimhigher, as the main national programme which aims to widen participation in HE by raising the aspirations and developing the abilities of young people from under-represented groups. By targeting the projects in this way, it is hoped that the projects will have a further effect of increasing participation more generally from all groups, based on the principle that if there is positive and measurable impact on the hardest to reach groups, there is likely to be a positive effect on all participants.

**Current projects**
The funded projects are:

- London Engineering Project
- Stimulating Physics
- Chemistry for our Future
- moremathsgrads
- Aimhigher national projects
  - Chemistry: The Next Generation (C:TNG)
  - RAISE - Raising Aspirations into Science and Engineering

All of the projects benefit from a partnership approach designed to ensure effective collaboration between schools, colleges, higher education institutions and employers, and co-ordination between existing initiatives and organisations.

These include:

- Aimhigher
- Action on Access (each project has a dedicated AOA adviser)
- Centres for Excellence in Teaching and Learning
- Higher Education Academy Subject Centres
- Department for Education and Skills
- Department for Trade and Industry
- Regional Development Agencies
- Training and Development Agency for Schools
- Sector Skills Councils
- Science, Engineering, Technology and Mathematics Network (SETNET)
- British Association for the Advancement of Science (The BA)

**STEM Activities in the Centres**
In order to fully interact and support all these initiatives, the participating Centres covering Biosciences, Materials, Computing, Mathematics, Engineering and Physical Sciences have appointed a STEM coordinator with the following remit,

- To visit each partner Centre to identify common areas of activity and/or interest.
- To promote cooperation between Centres.
- To develop an overview of activities in each Centre.
- To convene a STEM meeting of partners to firm up what might be needed and identify joint activities.
- To maintain an overview of STEM issues.
- To represent STEM interests at Academy and other meetings.
- To keep a close eye on the Academy and respond appropriately to demands for Centre input.
- To cooperate with,
  - AimHigher, SETNET, Action on Access, CETLs, DfE, DTI, Regional Development Agencies, Sector Skills Councils, BA.
- To coordinate collaborative bids for funding as and when opportunities arise.
- To analyse requests for bids to determine if there could be a combined response and whether the associated funding makes a bid worthwhile.
- To seek to locate personnel who might take up new initiatives (and some existing ones) on short term contracts.
- To help support collaboration between the HEFCE projects. For example,
  - Entrepreneurship – and how to assess it?
  - Creativity – and how to assess it?
  - Elearning and its assessment
  - Assessment
  - Ethics (using a PBL approach)
  - Taught PG education (which pulls together many Academy threads).
- To keep a watching brief on professional bodies' profile-raising activities in STEM designed to encourage increased applications at degree level. ■

**Strategically important subjects: science, technology, engineering and mathematics (STEM)**

**Background**
The dictionary definition of outreach refers to surpassing, outwitting or the act of 'reaching out'. The Funding Councils see it as "widening access and improving participation in higher education…… to equip people to operate productively within the global knowledge economy. It also offers social benefits, including better health, lower crime and a more tolerant and inclusive society".

Here in the Physical Sciences, whilst reaching out to widen access is an important part of our agenda, we see Outreach activities as primarily being targeted at improving the recruitment and retention of students and more recently, playing a key role in promoting 'strategic and vulnerable subjects' eg Physical Sciences, Engineering and Mathematics.

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# Development of a science e-portfolio

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**Centre wins new funding for e-portfolio development**

The Centre recently bid for funding under the JISC's (Joint Information Systems Committee) Distributed e-learning (DeL) programme to develop an e-portfolio for the sciences. The strand of funding for this work is being coordinated for subject centres through the Higher Education Academy - the Centre's umbrella organisation. We are pleased to announce that our bid to the Academy was successful and we are also happy to announce that the project officer position primarily funded to undertake this work has been filled and the appointee took up their post in the last few weeks.

At present, there is a perceived lack of discipline based e-portfolio provision with a focus on the subject related skills, especially for the sciences. Indeed, although there is a publication by the Royal Society of Chemistry called the 'Undergraduate Skills Record' it is only primarily available in paper format. No specifically developed e-portfolios exist for the other physical sciences.

**What is an e-portfolio?**

A number of e-portfolio systems have already been developed, such as LUSID, PADSHE and Profile. These are useful generic systems used by various institutions for e-portfolio provision but have mixed take-up across some disciplines simply because of their generic nature. In the physical sciences, personal development planning (PDP) and the e-portfolio systems providing the mechanism for recording student progress are seen as particularly awkward. This is because many academics and students have difficulty relating the discipline specific PDP to a generic portfolio.

By definition, an e-portfolio does not really contain content as it is the student that provides the content by recording their PDP evidence. For the purpose of this project we are defining an e-portfolio 'system' as the software tool (such as LUSID etc) that provides the computer based platform through which to submit content. Therefore, this project will focus on the development of a science e-portfolio 'framework' which will be the production of a discipline specific template that sits within an e-portfolio system for the student to record their content. This discipline specific e-portfolio framework will inform what the students record; how they evidence their progress and how they reflect on their development in a subject specific manner to which they can relate.

Many of the skills students develop during their physical science course, such as problem solving, analytical, and decision making skills, are common to all the sciences. Therefore, rather than simply develop a physical sciences e-portfolio we felt it would be appropriate to develop an e-portfolio framework which will also be widely applicable across the other core sciences. In order to develop this framework we will undertake a review of current practice with the use of e-portfolios, what systems are available and how (or if) they are being used in a discipline specific context.

**Intended project outcomes**

The Centre will also collaborate with other subject centres working on e-portfolios to collate information about existing e-portfolio (software) systems and to undertake a review of discipline based e-portfolio content/services/practices etc. The collaborative work will involve collating information provided by institutions and professional bodies and any occupational practices such as may be involved with law or medical related e-portfolios. We will also collaborate with the Centre for Recording Achievement (CRA) as external consultants for this work and will aim to undertake coordinated activities such as national events, in conjunction with the other subject centres, where appropriate.

The planned outcomes for this project will be a comprehensive review of e-portfolio use in the disciplines, together with a science based e-portfolio framework which can be implemented or customised to suit the needs of the individual. Another important output of this work will be to collaborate with the professional bodies for our disciplines; the Royal Society of Chemistry and the Institute of Physics, to develop a postgraduate extension to the framework which will be appropriate for CPD (continuing professional development) and professional accreditation. Thus the framework will be useful to users from university entry through to eventual accreditation as chartered scientist.

This work will complement previous JISC work by bringing a discipline specific view of e-portfolios and their use in higher education. With support from the CRA this project will help promote good practice in the adoption and use of a discipline based e-portfolio that exploits the experience already provided by other JISC funded e-portfolio projects. ■

# Assessment for learning

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Brains are quirky things. Some ideas seem easy to remember and others are much more difficult. And some people seem to find 'my' difficult things easy, and vice versa. There seems no doubt that it is easier to remember something when the context is familiar, and also that 'exercising' new information can aid (or enable) subsequent recall.

When trying to learn about new concepts (rather than just remembering a new name) the process is clearly more complicated. A view of the whole (a mental schema) is needed before the relationships between components can be appreciated, and if the schema contains misapprehensions the learning can become deeply flawed.

If a tutor is involved in the process, then a learner's statements about the whole (as they currently see it) will reveal information about the mental schema they are forming that can be used as a diagnostic, to check for inconsistencies or misapprehensions. In a conversation such statements will sometimes be spontaneously offered, in the spirit of reassuring the tutor that the whole is being conceived correctly. Other such statements will involve predictions about the consequences of what the tutor has already explained. In both cases, the information can be used by the tutor to correct misapprehensions at an early stage, so that the schema being created will more closely match the concept being described and the learning can be more efficient.

If the learner does not volunteer such statements, a tutor may ask questions designed to prompt them. Such questions will also 'exercise' the new concepts, so that the learner is better able to recall the details later. In a class or lecture situation, these questions are traditionally avoided by most students using well known techniques. Unfortunately, therefore, they tend to be answered by students who do understand, so that no useful diagnostic feedback is provided to the tutor.

Technology is now able to offer some alternatives to this. Electronic voting systems provide a means for each student to be able to respond individually to such questions. Although most voting systems allow only a single selection from a list of options, it is often the case that the major misconceptions are quite well known and questions can be designed to reveal their prevalence in the group of learners.

Remediation can be achieved by peer discussion or by other means but, most importantly, can be corrected immediately, before further development of the concepts takes place.

Where an e-learning environment is used to present the concepts and ideas, it is now becoming possible to integrate e-questions into these to achieve the same sort of effect. As before, the questions have to anticipate the types of misconceptions that most frequently occur, but the remediation materials can be reached directly from the question answers. The range of different question types available means that these can potentially be better tuned to the needs of the learning experience.

This style of e-questioning can also be deployed in a different form, where the questions come before the concepts start being formed rather than after. The questions would be designed to encourage the development of the schema rather than just checking its validity. Such a scheme would be similar to the so-called 'Socratic Method' of teaching.

An unfortunate legacy of the different technologies that contribute to this e-learning scenario is the almost inevitable use of the words 'tests' or 'assessments' for computer based questioning. Thus, the use of such questions can easily be misrepresented by students as yet another method of assessing their performance, rather than being provided to aid their learning. On the other hand, student responses to questions of this type could indeed be used as a secondary assessment system, if the scheme was used across many parts of a course. Answers from polling schemes and intuition questions could be used to provide useful indications of aspects of students learning. Great care would be needed in the interpretation of the figures, and changes in approach by a learner could be indicative of greater learning than simple 'correct' answers. If assessment could be integrated into the learning experience in such ways, however, the need for the more formal types of assessment might be reduced in both quantity and frequency – which would all be of benefit to staff and students alike. ■

# Development Project Report

**Physical Sciences Development Project 2005**

**Supporting and Retaining New Students in the Chemical Sciences**

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Web-based resources and a hard copy workbook have been developed to assist student learning in the first year of a UK chemistry degree. The rationale is to provide students having non-traditional backgrounds in chemistry with materials to support their transition to tertiary education.

The on-line resources produced in this project are freely available on the following web site:
'Introduction to Organic Reaction Mechanisms' at
http://www.hull.ac.uk/chemistry/mechanisms/index.php?res=high&scene=4&reaction=
The hard copy work book is available as a free download as an Acrobat file (pdf):

The interactive website, 'Introduction to Organic Reaction Mechanisms' consists of:

- Six different organic reaction types:
  - Electrophilic Addition
  - Electrophilic Substitution
  - Elimination
  - Nucleophilic Addition
  - Nucleophilic Substitution
  - Nucleophilic Addition/Elimination
- For each reaction type an interactive movie represents the reaction.
- 'Curly arrow' depictions are given for each reaction type.
- A 'curly arrow' test yourself quiz is available for each reaction

The 83 page hard copy workbook consists of 10 main sections.
The topics selected for each section represent areas in physical chemistry which students traditionally find the most challenging.

- The topics chosen are:
  - Chemical calculations
  - Thermodynamics
  - Enthalpy and Hess's Law
  - Born-Haber Cycle
  - Bond Enthalpies
  - The Second Law
  - Gibbs Free Energy
  - Kinetics
  - Equilibrium Reactions
- Each section consists of worked examples and answers followed by a set of related problems.
- Answers are given to the problems at the end of each section.

The workbooks can be used individually as self-study or revision guides or in small-group teaching situations such as problem workshops.

The workbooks have been piloted with a small group of self-selected students and used as a revision guide. Thirty percent of the students reported to use over 75% of the problems in the workbook and forty percent used over 50% of the problems. Seventy percent of the students reported that they found the workbook fairly helpful for revision with the remainder finding the book very helpful.

The most useful sections were found to be on Hess's Law calculations (74%), Introduction to Thermodynamics (70%), Gibbs Free Energy (69%) and the Second Law of Thermodynamics (68%).
Areas for further development were basic spectroscopic theory (vibrational and rotational) and electrochemistry.

The background and development of the project and the issue of supporting and retaining students in the physical sciences has been disseminated at various UK higher educational institutions between January and June 2006. ■

# Development Project Report

**Physical Sciences Development Project 2005**

**A database of useful MCQs for Physics (DUMP)**

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This project is concerned with the development and online publication of a browse-able repository of multiple choice/ multiple response questions (MCQs and MRQs), suitable for student self-study to provide formative assessment in introductory undergraduate Physics courses. It will be freely available to the UK HE community upon completion and we anticipate further developments of the system beyond the lifetime of this project.

The importance of formative assessment in undergraduate learning is well-established and practitioners in HE would support the strategic goal of ultimately wanting our undergraduate students to develop into more autonomous learners. To this end, in Edinburgh we have previously developed over a number of years an extensive bank of MCQs that can be used by our own students to test their understanding of material and to provide instant formative feedback. The questions are delivered electronically via the Web and students can access them from wherever and whenever they choose. (These materials form part of the introductory course in Physics at Edinburgh). Such materials are certainly not unique around Physics departments in the UK, textbook publishers etc.

However there are certain features of such materials available 'out there' that can impede or even preclude their widespread use: one is granularity of the material ('I want that one, but not that one...') and another is the (lack of) interoperability of data formats ('I use package/VLE X but your data is in Y format') and poor support for Mathematical content in existing implementations and specifications. This project seeks to address these shortcomings and provide the entire bank of over 400 hundred questions for use in the Physics HE community, in a browse-able and customised exportable format.

The majority of the questions related to mechanics, oscillations and waves, with some excursions into optics and quantum mechanics. A future project will aim to develop a question submission interface accessible via the web to allow users to deposit in the library as well as take out resources.

The granularity of the resources will enable people to pick and choose their resources; the data formats for export will encompass the vast majority of possible use scenarios including:

- A collection of user-selected questions, suitable for mounting on local web pages (for immediate deployment and thus student use without the need for any specialist server or software beyond a web browser).
- Question sources in standards-compliant formats (eg the QTI specification format) for import into local systems or VLEs.
- .rtf, .pdf file formats, for both students (question only) and instructors (question plus answer plus all feedback).
- Raw question source in our simple (documented) XML format.

The use scenarios can be varied; we have used these questions in the past for both formative self-assessment exercises for the students and also as in-class questions in lectures with electronic voting systems to promote student interaction and engagement with the lecture. They can also be employed in diagnostic testing or summative assessment of conceptual understanding.

The project has comprised an (academic) quality control exercise, to ensure suitable coverage of introductory topics and provision of appropriate feedback (particularly for incorrect answers) and technical aspects of the delivery of the web-based system, building on the content management framework we use in Edinburgh.

**Project Status**

This project runs from October 2005 to October 2006 and is nearing completion. We anticipate opening up the library for browsers by the end of the 2006 calendar year. ■

# Development Project Report

**Physical Sciences Development Project 2005**

**Web Based Chemistry Software for Formative Assessment**

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**Summary**
Stage 1 of the development project involved porting The Chemical Thesaurus Reaction Chemistry Database to the web. This necessitated understanding the open source scripting languages HTML, PHP and MySQL, individually and how they work together in concert.

Stage 2 of the project involved building the Chemistry Tutorials & Drills web site: www.chemistry-drills.com using HTML, PHP and MySQL and pulling data from The Chemical Thesaurus database.

The Tutorials & Drills website is designed to address learning & understanding – the pedagogy – by providing a discussion of crucial chemistry topics and database driven formative assessment web pages that test the accumulation of knowledge.

The Chemistry Tutorial & Drill pages currently deal with:

- The identification of organic functional groups
- Applying valence shell electron pair repulsion (VSEPR) theory
- Balancing chemical equations

Being database driven, visitors to the site are exposed to dozens – and in some cases hundreds – of drill problems and it is a simple matter to add more problems to the database.

The web based Chemical Thesaurus, www.chemthes.com, is a unique Internet resource. Statistics show that over the period April, May & June 2006 the website received an average of 13,000 unique visitors a month, with 10 pages viewed per visit, giving 130,000 page views [page impressions] per month.

Website statistics show that the Chemistry Tutorials & Drills site is receiving 1000 unique visitors a month, although it is too soon to get full usage statistics as the site only went live in early June 2006, and the summer months are notoriously slow for academic/educational web sites.

**The Future**
Work continues on porting The Chemical Thesaurus reaction chemistry database to the web and developing the Tutorials & Drills site. Currently most of the work involves small tweaks to the text and fine tuning the HTML, etc. However, there are ideas for substantial future developments.

Since The Chemical Thesaurus has been ported to the web, the application has gained gravitas and Meta-Synthesis has joined the club. This is already opening up collaboration opportunities.

Future directions and developments include:

- The More & Advanced Functional Groups page lists 300 functional groups that have been collected in The Chemical Thesaurus. Currently there are no drills associated with this data set. These advanced FG drills will be added when a user interface has been devised.
- More topics needed to fill out the Tutorials & Drills web site, including: Identify the Material Type, Identify the Simple Ion and/or Salt, Single Step Synthesis, Predict the Product of a Reaction, etc. (Many of drills these have been prototyped in FileMaker Pro and only require porting.)
- Build pages that enable teachers, lecturers and students to create their own selections from the supersets of data held in the ChemThes and the Tutorials & Drills website. For example, a teacher may wish to expose and drill students on a specific set of 10 redox half-reactions. The interface for this could prove tricky, but it will be possible to add this functionality.
- Collaborate with other chemistry web developers who are writing educational pages and virtual textbooks by offering to provide database driven drills.
- The Chemical Thesaurus web application needs to be further integrated with the Chemogenesis web book and vice versa.
- There are many types of chemistry software available, including quite a number of retro-synthetic-analysis programs that take a large organic molecule and suggest a synthetic route by identifying the strategic bonds and functional group interconversions. However, there are no serious 'Reaction-CAD' programs that [attempt to] predict the outcome of a chemical reaction and so allow a chemist to design a reaction system on a computer. In other words, there is no chemical equivalent of engineering computer aided design (CAD) software. Reaction-CAD software will require an underlying reaction chemistry database such as The Chemical Thesaurus. ■

# Academy update

**Adapted from Higher Education Academy Updates (www.heacademy.ac.uk/news/updates.htm). or from Higher Education Academy News (www.heacademy.ac.uk/)**

by
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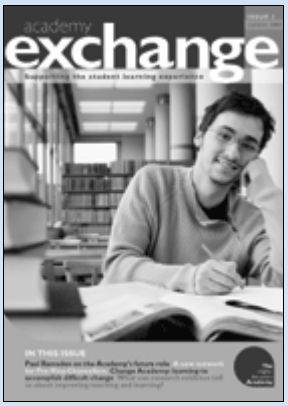


**e-Tutor Winners 2006**
The Higher Education Academy, the Association for Learning Technology (ALT) and the Times Higher Education Supplement have announced the winners of the 2006 e-Tutor of the Year competition, which celebrates innovation, good practice and achievement in the field of e-learning in higher education.

**Academy funds 18 new research projects**
The Higher Education Academy has announced funding awards totalling over £500,000 for research projects examining aspects of the student experience in higher education.

**Academy's new approach to recognising commitment to teaching and learning**
Over the past few months the Higher Education Academy has been developing a new approach to recognising individual commitment to teaching and the student learning experience.

**National Teaching Fellowships awarded**
Fifty lecturers and learning support staff have been awarded prestigious National Teaching Fellowships from the Higher Education Academy.

**Education for Sustainable Development**
The Academy has published two guides on Education for Sustainable Development (ESD) in HE courses.

One is intended to inform senior managers in HEIs on progress in embedding ESD in the curriculum. The other is intended to show employers, trade unions and the professions how HE is ensuring that students develop the skills and knowledge that will enable them to think and act critically and effectively about sustainability issues.

Both guides summarise the outcomes of the first year of a programme of support for ESD undertaken by the Academy's Subject Centres and give examples of how different disciplines are integrating ESD in their courses.

**Subject Network Prospectus**
The Academy has published a new Subject Network Prospectus, detailing the activities and services available from the 24 Subject Centres, it is now available; copies can be ordered from enquiries@heacademy.ac.uk.

**Personal Development Planning**
A new leaflet on how the Academy can support institutions and provide consultancy on the development and implementation of Personal Development Planning and e-portfolios is available from enquiries@heacademy.ac.uk.

The Academy is carrying out this work in partnership with the Centre for Recording Achievement (CRA).

**Academy Exchange**
Academy Exchange, the Higher Education Academy's magazine, was relaunched in August 2005.

It is published four times a year and will encourage the exchange of ideas, practices, news and support on learning and teaching issues, as well as providing news from the Academy. It will seek to inspire change and to contribute to the enhancement of the student experience. Each issue will examine a different theme related to the student learning experience.

It can be viewed at www.heacademy.ac.uk/academyexchange.htm or printed copies can be ordered from exchange@heacademy.ac.uk.

**Leaflets**
The Academy has a range of leaflets on different areas of their work. You may download the leaflets from www.heacademy.ac.uk/Leaflets.htm or you may request printed copies from enquiries@heacademy.ac.uk.

**National Student Survey**
The Higher Education Academy is working with higher education institutions to help them make the most effective use of the results of the National Student Survey (NSS).

The Academy is commissioning a study, starting this Autumn, on the ways in which universities are using the NSS results and website in their own procedures for improving the student learning experience.

For further information about the Academy's work with institutions on the NSS see the website at www.heacademy.ac.uk/NSS.htm

The results of the second National Student Survey were published on 23 August 2006 and are available at www.tqi.ac.uk. ■

## New Development Projects

The Development Projects funded by the Centre in 2006/2007 are:

**A Foundation Course in the Chemical and Physical Science of Cooking**
John Bradley (Chemistry, University of Hull)

**Testing your Organic Chemistry Knowledge to Reinforce Comprehension and Understanding using Web-based Multiple Choice Questions**
Andrew Boa and Jason Eames (Chemistry, University of Hull)

**Narrative Science**
E Hywel Evans and Chris Hall (Earth Ocean & Environmental Sciences, University of Plymouth)

**An Investigation of the Effectiveness of Foundation Degree Courses in Further Education Colleges in Preparing Science Students for the Final Year**
David Harwood (Institute for Science Education, University of Plymouth)

**Opportunities in Forensic Science**
Julie Mennell (Centre for Forensic Investigation, University of Teesside)

**Development of Project Based Forensic and Environmental Practical Activities for Integration into the Chemistry Curriculum**
Christine O'Connor (Dublin Institute of Technology)


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*The Physical Sciences Centre is funded by the Higher Education Academy (www.heacademy.ac.uk) and is part of the Academy's Subject Network. The Centre is supported by the Universities of Hull, Liverpool and Surrey .*


*Offers to contribute to the newsletter are welcomed. Please contact the Centre.*

# Staff changes

**Administrator**
Sadly, our Administrator, **Katie Glover**, left the Centre during August for a new post in the Business School at Hull University. We would like to take this opportunity to thank Katie for all her hard work for the Centre. We (and I am sure many of you) will miss Katie and we wish her well for the future. A new Administrator, **Liz Pickering** (from the local chemistry department at Hull), has been appointed and will take up her post at the end of October. In the meantime please use the generic email address (psc@hull.ac.uk) to contact the Centre.

Liz Pickering

**STEM Coordinator**
In addition to his work, 1 day per week, as a consultant to the Centre **Steve Walker** has been appointed (on a 1 day/week basis) as STEM Coordinator for the science, technology, engineering and mathematics Centres. You can read more about this activity on page 5 of this newsletter but Steve will initially focus on outreach.

**New staff**
It is with great pleasure that we welcome two new staff members to the Centre...

**Ruth Wellock**
Ruth is a chemist and has recently completed a PhD in chemometrics in the Chemistry Department at Hull University. She joined us at the end of August as an Academic Coordinator to help with the full range of activities of the Centre and is based at Hull.

Ruth Wellock

**Tracey Madden**
Tracey has been authoring on-line learning materials recently but is an ex-teacher and a PhD physicist. She has been taken on as a project officer to take prime responsibility for the development of the electronic version of the science student portfolio (see page 6). Tracey started 1st September at Hull. ■

Tracey Madden

## Events —2006/7—

- Physics and public engagement with Science, 11th October, London*
- Entrepreneurship, 22nd November, Leeds
- Investing in the future: new degrees in Physical Science, 13 December, London*
- Flexible Delivery, 10th January, Birmingham
- Postgraduate Demonstrators, 21st February, Manchester
- Animations & Flash, 21st March, Edinburgh
- Departmental Representatives Meeting, 24/25th April, London
- Science Learning and Teaching Conference, 19/20th June, Keele

** organised by IoP*

*Contact us or visit our web site for details.*